EXAMINED
IMP. BUR. OCT 1915 ENTOM.

UNITED STATES DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN

rec'd. 1919. -A-2615

WASHINGTON, D. C. 675 JULY 6, 1915.

Contribution from the Bureau of Entomology, L. O. Howard, Chief.

THE ROUNDHEADED APPLE-TREE BORER.[1]

By FRED E. BROOKS,
Entomological Assistant, Deciduous Fruit Insect Investigations.

INTRODUCTION.

Several species of insects occur in the United States that in their larval or grub stage injure apple trees by boring into the bark and wood. The most destructive of these, in the eastern half of the country, is the roundheaded apple-tree borer. The borers of this species hatch from eggs deposited by a rather large beetle in or under the bark of the trees, usually near to the ground, and feed to such an extent on the inner bark and wood that the trees are greatly weakened and often die as a direct result of the injury. Trees of all sizes are attacked, but those from 3 to 10 years old suffer most. As the borers feed they throw out, through small holes which they make in the bark, sawdustlike castings of a reddish color. (Fig. 11.) Heaps of these castings found at the base of apple, pear, or quince trees are

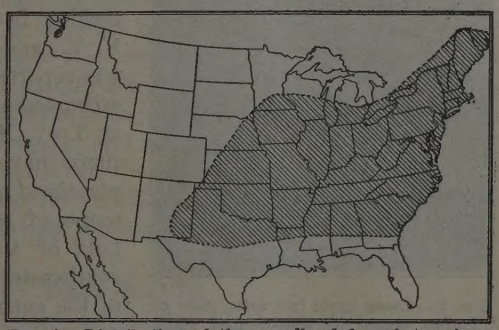

FIG. 1.—Distribution of the roundheaded apple-tree borer (*Saperda candida*). (Original.)

NOTE.—This bulletin describes an insect which in the larval or grub stage is most destructive to apple orchards in the eastern half of the United States. (See fig. 1.) Methods for its control are given.

[1] *Saperda candida* Fab.; order Coleoptera, family Cerambycidæ.

always an evidence that the trees need immediate attention. Frequently an examination of an orchard induced by finding one tree with castings at the base will reveal the fact that many trees are affected and that serious injury has already been done.

In many localities the borers of this species are so abundant that when young apple orchards are neglected practically all the trees will be killed or injured beyond recovery before they are 10 years old. (Fig. 2.)

HISTORY AND DISTRIBUTION.

The roundheaded apple-tree borer is a native of North America, and has been known in this country as an enemy of cultivated fruit trees for nearly a century. Before orchards were planted here it doubtless bred in the wild trees, which it still inhabits.

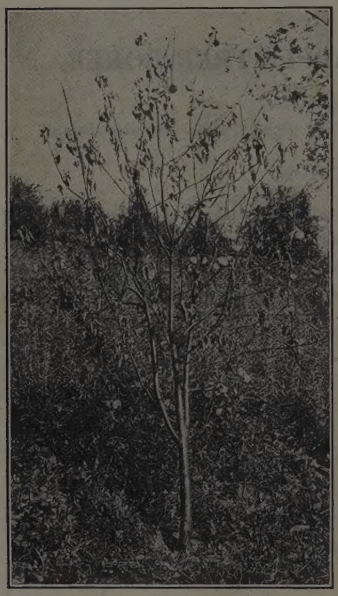

FIG. 2.—Young apple tree dying from injuries caused by roundheaded apple-tree borers. (Original.)

The species was first described by Fabricius in the year 1787. It was redescribed by Thomas Say in 1824, the description containing a note that the insect injured apple trees by boring in the wood. In 1825 it was observed to be attacking fruit trees about Albany, N. Y., and during the same year was reported to have caused a loss estimated at $2,000 in one orchard at Troy, N. Y. Since that time there have been frequent complaints of great injury over a wide scope of country in the eastern half of the United States and southeastern Canada. Instances of the entire destruction of apple and quince orchards by this insect are not uncommon, and the cost and trouble of protecting trees against its ravages amount to an important item in the expense of orchard maintenance throughout the region where the species occurs. Its known range may be bounded by a line extending from near the mouth of the St. Lawrence River westward through Quebec and Ontario to Minnesota, thence through Nebraska, Kansas, New Mexico, Texas, Louisiana, Mississippi, Alabama, and Georgia to the Atlantic coast. (See fig. 1.) Curiously

enough, this line, except in its southwestern extent, bounds also rather definitely the distribution in America of the service tree,[1] which is one of the borer's favorite host trees.

Throughout the range of this insect there are many restricted localities where it does not occur, or, at least, is so rare as to have escaped notice. It is not uncommon to find the borers exceedingly abundant in one orchard while in other orchards, perhaps not more than a mile away, it may never have appeared in sufficient numbers to have attracted attention. This tendency of the species to be present in one locality and absent in an adjoining one is an interesting phase of its distribution. It has been noticed that where soil conditions and other causes favor an abundant growth of wild trees in which the borers breed, near-by cultivated trees will suffer more than where such natural breeding places are not present.

As a rule the parent female beetle in ovipositing does not move far from the tree in which she was developed, providing there are suitable trees near by in which she can place her eggs. (Fig. 3.) This tendency of the female to spend her adult life and provide for her progeny within a restricted area accounts very largely for the irregularity in the local occurrence of the borers. An adult female issuing in an orchard is quite likely to deposit all her eggs within a few rods of her host tree; thus it is that in infested orchards that have not been entirely neglected in respect to this pest the borers are likely to be found infesting groups of half a dozen or more trees standing close together. It is a common observation, especially in newly planted orchards, that the trees standing near to woods in which service, wild crab, or mountain ash trees grow, or those adjacent to old infested orchards, are the ones to be first attacked by the borers. This is so because the woods and neglected orchards are breeding places for the borers, and when the adult insects appear they select the near-by orchard trees for attack. This is an important point to keep in mind in the work of ridding orchards of, and keeping them free from this pest.

FOOD PLANTS.

This borer, so far as is known, confines its attacks to a few species of trees belonging to the family Rosaceæ. Even among the limited number of its host plants the insect shows considerable discrimination, greatly preferring as food some species of trees above others. Of our cultivated fruits, quince, apple, and pear suffer about in the order named. Service (figs. 18, 19), wild crab, mountain ash, thorns of different species, and chokeberry are the wild or native trees which serve as its food. These wild trees are named, also, about in

[1] *Amelanchier canadensis.*

the order for which preference is shown, service, crab, and mountain ash being more often attacked than the others.

The relation of native host trees to the local distribution of the borers is important. Frequently a clump of these trees growing in a neglected field or those growing in the woods will be infested

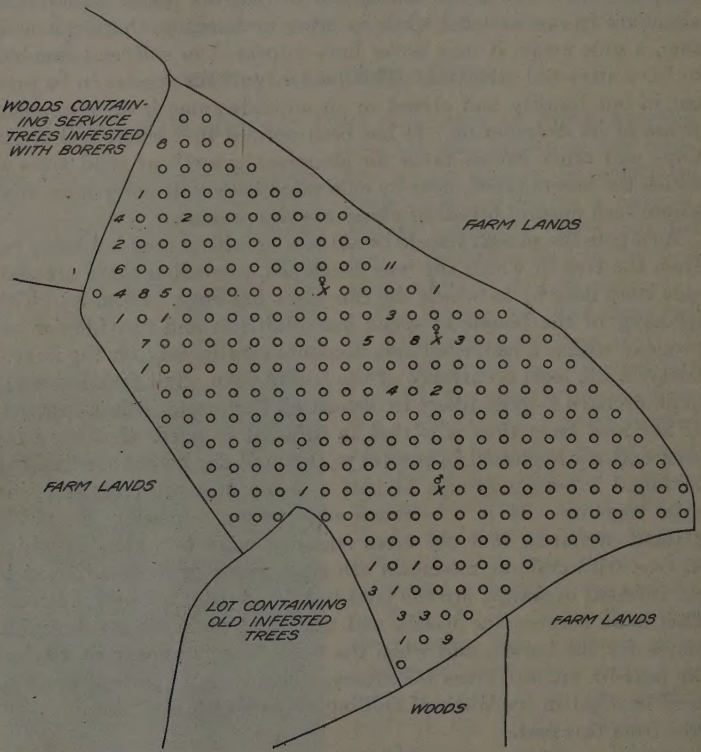

FIG. 3.—Diagram of orchard illustrating the tendency of the adult female roundheaded apple-tree borers to group their eggs about the places where they develop. o, o Represent trees; × represents trees from which male and female beetles issued in 1914; figures represent number and position in the orchard of eggs deposited in 1914. Note how eggs are grouped about the two orchard trees from which females issued, the lot containing old infested apple trees and the woods in which the borers breed in service trees. (Original.)

and will year after year be a source, and possibly the principal source, from which adult insects are produced to fly out and deposit eggs in adjacent orchards.

In exceptional cases peach, cherry, and plum trees are said to be attacked by this species, but this occurs very rarely, the common peach borer being the larval form of an entirely different insect.

LIFE HISTORY.

To pass through the four forms or stages of its life cycle this insect requires in some cases two years and in others three years. In the central part of West Virginia about two-thirds of the individuals reach the adult stage the second season after hatching, while the other third do not become adult until the third season from the egg. It is quite probable that throughout its northern range most or all of the individuals require three years to complete the life cycle, while farther to the south, where the annual period of feeding is longer, all the borers may pass through the same transformation in two years.

THE EGG AND OVIPOSITION.

The adult borers issue from the trees during late spring and early summer, the emergence of the brood occupying a period in any given locality of from 15 to 20 days. Between the southern and northern limits of the species' range the calendar dates of the beginning and ending of the emergence of adults probably vary about two months.

FIG. 4.—Egg punctures of roundheaded apple-tree borer in apple bark. Three punctures are to be seen. Natural size. (Original.)

The beetles occasionally fly by night, but are less nocturnal in their habits than was formerly supposed. Emergence from the trees takes place by day, as does the laying of most, and probably all, of the eggs. The males appear two or three days in advance of the females and usually die first. In a week or 10 days after the females issue egg laying begins and is continued for 40 or 50 days, a single female depositing normally from 15 to 30 eggs. In preparing a place for the egg the female makes use of her jaws to cut a short, curved incision in the bark (fig. 4); then with her strong, extensile ovipositor she forces a side opening from the bottom of the incision (fig. 5), at the end of which a single egg is placed. During the period of oviposition a female may pass several days without depositing eggs and may then lay from 1 to 5 within an hour. Usually at least 2 or 3 eggs are laid at a time, the operations attending the laying of each following close together. The several eggs are as a rule placed in one tree. This explains the fact, which has often been noticed,

that where one borer is found others are quite likely to be in the same tree.

The eggs are inserted through the opening in the bark and are placed from one-fourth to one-third of an inch to one side of the entrance. In young trees they are deposited between the bark and wood (fig. 6), but in old, thick-barked trees they may be placed between the layers of bark.

The yellowish or rust-brown egg (fig. 6) is slightly more than one-eighth of an inch long by one twenty-fifth of an inch wide at the middle, both ends tapering to the rounded points. The shell is tough and plastic, allowing the egg to shape itself more or less to the space which it occupies in the tree. The eggs hatch in from 15 to 20 days. As a rule they are placed in the tree just above the surface of the ground. Where the female can find a crack or opening between the soil and the base of the tree large enough to enter, she may place eggs an inch or so below the surface of the ground (figs. 7, 8). Rarely the eggs are deposited higher in the tree about a crotch or an uneven place on the trunk. In the latitude of West Virginia and Maryland egg laying is in progress from the last of May until the middle of July, the period being somewhat later in the season than the dates given at the higher elevations of the mountain districts.

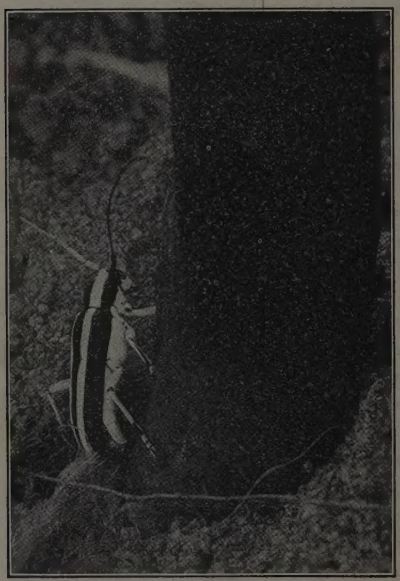

FIG. 5.—Adult female of the roundheaded apple-tree borer in the act of depositing an egg. Slightly enlarged. (Original.)

THE LARVA.

The larva, or borer (figs. 9, 10), is a whitish, footless grub, with brown head and black jaws. It attains a length when full grown of nearly an inch and a half. On hatching, the young borers attack the inner bark, where they continue to feed until late in the season; whereupon some of them, especially in young trees with thin bark,

gnaw their way into the sapwood. During the first season the young borers feed and grow rapidly, and where several occur in one tree they may completely girdle and kill it before winter. Their burrows at this time are in the form of broad, irregular, usually more or less circular galleries beneath the outer bark, near to the point where the egg was laid. The borers avoid one another in the tree, and the forms of their galleries are often affected thereby, being made narrower and more elongate to avoid contact. This habit increases the liability of their being overlooked by orchardists who practice the digging-out, or "worming," method.

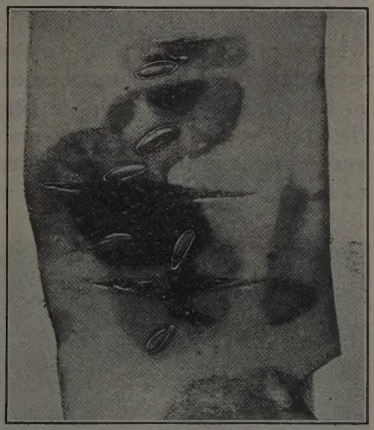

FIG. 6.—Inner surface of bark peeled from young apple tree showing position of eggs of roundheaded apple-tree borer. Natural size. (Original.)

As the borers feed they keep an open space in the burrows about themselves, thrusting their castings into abandoned corners or out through small holes made by them in the bark. These castings form little heaps of reddish, stringy wood fragments around the base of the tree (fig. 11) and afford one of the sure marks by which infested trees may be detected.

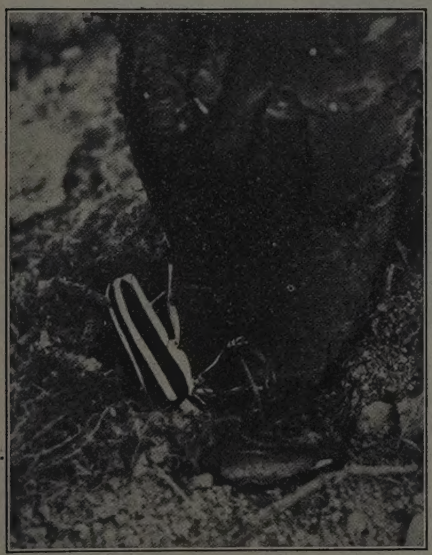

FIG. 7.—Female beetle splitting the bark of a young apple tree just below the surface of the ground preparatory to depositing an egg. (Original.)

The borers spend their first winter in the burrows near the ground and resume feeding early the following spring, attacking now the solid wood almost exclusively, and, in young trees, penetrating to the heart. During the summer those that are to attain the adult stage the following year begin to extend their burrows up the trunk a half

inch or more beneath the bark. As previously stated, part of the borers do not become adult until they are 3 years old; these remain feeding in the wood near the ground until the third summer, when they, too, work their way up the trunk in the manner just described. The winter previous to pupation is passed by the borers in the pupal cell or chamber (fig. 12). This chamber is a space at the upper end of the gallery which curves out to the inner bark above and contains in the curved portion next to the bark a small quantity of fine, sawdust-like particles of wood. The chamber is 2 or 3 inches in length, being limited at the lower end by a packing of coarse, string-like wood fiber. In the spring the point at which the chamber extends to the inner bark begins to show from the outside as a slightly depressed, dead spot in the bark. This spot marks the place from which the adult is to issue later, and is especially noticeable on young, smooth-barked trees.

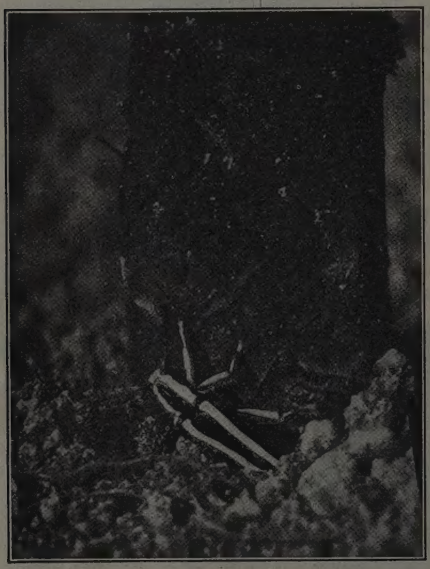

FIG. 8.—Female beetle placing an egg in the tree below the surface of the ground. (Original.)

THE PUPA.

The pupa (fig. 13) is an intermediate form between the larva, or borer, and the beetle which deposits the eggs. In this form the insect is of about the same color as the borer, but the shape is greatly changed, the legs, wings, antennæ, and other appendages which the adult is to possess being now visible. The insect does not feed while in this stage and is incapable of motion except that of wriggling about in the chamber. It occupies a vertical position in the tree with its head up. The change from the borer to the pupa takes place at the time apple trees are in bloom, the pupal stage covering a period of about three weeks.

THE ADULT.

The borer attains the adult stage 10 days or 2 weeks before it leaves the pupal chamber. When ready to issue it gnaws a circular hole through the bark (fig. 14) and escapes.

The beetles average about three-fourths of an inch in length, exclusive of the antennæ. The color is light brown above with

FIG. 9.—Roundheaded apple-tree borer. First summer in tree. Natural size. (Original.)

FIG. 10.—Roundheaded apple-tree borer. Second summer in tree. Natural size. (Original.)

two broad, white bands, joined in front, extending the full length of the back; the underparts and front of the head are white. The female is larger than the male, the body being thicker and heavier. (Fig. 15.)

All the beetles in a given locality issue from the trees within a period of two or three weeks. After they emerge they seek the branches of the trees, where they spend the greater part of their lives

resting among the foliage. The females make short flights in search of trees in which to oviposit. Rarely they fly for a considerable distance, but where suitable trees in which to deposit eggs are abundant they usually pass their lives within a few rods of the trees from which they issue. (Fig. 3.) The males in seeking their mates make longer and more frequent flights. Both sexes are active by day and at twilight in warm weather, and, although they occasionally fly at night,

FIG. 11.—Castings of roundheaded apple-tree borers at base of young apple tree. (Original.)

the hours of darkness are more likely to be spent in quiet among the branches.

The adults do considerable feeding on the bark of twigs and on the midribs and stems of leaves (fig. 16), and they also show a fondness for the moisture that is contained in castings thrown from trees by borers still in their larval stage. This habit is not important from the standpoint of any noticeable injury which such feeding does to the tree, but it causes the death of some of the beetles when they

feed from trees that have been sprayed with arsenical poisons and suggests spraying with arsenicals as a possible means of combating the borers.

When ready to oviposit the female usually crawls down the trunk of the tree to the ground and slits the bark with her mandibles (figs. 4, 7), after which she turns around, inserts her ovipositor into the slit (fig. 5) and deposits an egg, the whole operation occupying about 10 minutes. She may deposit as many as 5 eggs without resting and will then crawl back up the trunk or move away a short distance over the ground and fly to the branches above or to a neighboring tree.

The average life of a beetle is about 40 or 50 days, although individuals occasionally live to be 70 or 75 days of age.

FIG. 12.—Roundheaded apple-tree borers in pupal chambers. Position occupied during winter previous to emergence as adults. (Original.)

NATURAL ENEMIES.

All observers agree that woodpeckers destroy great numbers of the borers by drilling into the trees and removing them from their burrows. The marks made by these birds in searching for borers may be found in the trunks of trees in almost any infested orchard. In some cases from 50 to 75 per cent of the borers are destroyed in this way. Most of the borers devoured are taken from the pupal chamber or while they are making the ascent of the trunk preparatory to pupation. It is rather unfortunate that the birds so often wait until the borers have done the principal part of their injury to the tree before they remove them. Probably both the hairy and downy woodpeckers feed on the borers.

One hymenopterous parasite, *Cenocoelius populator* Say, has been reported from Indiana, but in many localities this species is doing very little in the way of holding the borers in check.

METHODS OF CONTROL.

This insect in its borer stage lives and feeds under the bark where no poisonous or contact sprays or washes can be directed against either its food or its body, and consequently it has always been considered a difficult pest to control. Modern insecticides have not been used so successfully against it as against many other common insect

FIG. 13.—Pupæ of roundheaded apple-tree borer. (Original.)

enemies of the orchard. However, there are practicable methods whereby the borers may be destroyed, or oviposition prevented, and injury thus greatly reduced or entirely eliminated, even in orchards that have suffered severely. In the use of these methods timeliness and thoroughness are essential factors, just as they are essential in the processes of combating most insect pests.

WORMING.

Removing the borers from trees by the use of a knife and piece of wire, a practice commonly known as worming, is one of the oldest and, when thoroughly done, one of the most effective ways of dealing with this insect. In worming trees the operator should be equipped with a strong pocketknife, a piece of small wire, a vial of carbon bisulphid, a small quantity of cotton batting, and a garden trowel. (Fig. 17.) These articles may be carried very conveniently from tree to tree in a small basket. The knife should have a long, sharp blade and the wire should be bent to form a small hook at one end and a circle or ring at the other. Into the ring a scrap of white or brightly colored cloth should be tied as a safeguard against losing the wire. The trowel is for use in scraping away from the base of the tree any earth or litter that interferes with a close search for castings of the borers. When castings are found the bark should be cut away sufficiently to allow the borer to be traced by its burrows and killed. If the cutting is done with care, and the borer secured, the wound will usually heal without noticeable injury to the tree. The natural healing tendency of the tree may be assisted by covering the wound with lead paint.

FIG. 14.—Adult roundheaded apple-tree borer just emerged from exit hole in bark. Natural size. (Original.)

During the first few months of its life the borer is easily found and destroyed, but after it has been feeding a year or more the difficulty of locating it is increased, since at that time its burrows extend more deeply into the tree. However, with a little practice one becomes rather adept at securing the borer regardless of its age or the position it may occupy in the wood.

As the borers engage in burrowing in the tree they keep a clear space behind them, and up to the time the pupal cell is being constructed there is usually nothing to prevent inserting the wire into the exposed end of the burrow and hooking them out. While the

pupal cell is being formed, the burrow below, which up to that time has been kept open, is packed for several inches with wood fiber so that the wire can no longer be used successfully. In all cases where curves or other obstructions in the burrows interfere with hooking the borer out, a little cotton batting dipped in carbon bisulphid should be inserted into the hole and the opening plugged with moist earth. The gas coming from the carbon bisulphid will penetrate all parts of the burrow and will kill the borer. It should be borne in mind that the gas is highly inflammable and that fire should be kept away.

FIG. 15.—Adult male and female roundheaded apple-tree borer. Male on left, female on right. Slightly enlarged. (Original.)

In extensive orchards where worming is done on a large scale by promiscuous labor some of the helpers are likely to become careless and overlook or neglect to destroy an occasional borer. Every female so overlooked stands a good chance of maturing within a year or two, when it will deposit eggs in a half dozen or more near-by trees, causing thereby a continued and an increased infestation in that particular part of the orchard.

The importance of the following points should be kept in mind by all persons who practice this method of borer control:

1. Borers should be removed from the trees as soon as possible after hatching.

2. Every borer in the orchard should be found and destroyed.

3. Borers should not be allowed to breed in cultivated or wild host trees growing within at least 200 or 300 feet of the orchard.

It is the practice with many orchardists to put off the fall worming of trees until after winter apples are gathered. Observations have shown that this practice permits the borers, which feed rapidly while young, to remain in the trees too long for safety. Even in so short a time small trees may be girdled and killed and larger trees seriously injured. In the latitude of West Virginia and Maryland the

work should be done not later than the 1st of September; farther south it may be done several weeks or a month earlier, and north of the States mentioned the time will be correspondingly later. A second examination should be given the trees the following spring to secure borers from belated eggs or those that may have been overlooked at the fall worming.

The fact that the adult female does not habitually wander far in depositing her eggs (see fig. 3) is greatly to the advantage of the orchardist who depends on worming to save his trees. When once his

FIG. 16.—Twig and leaf of apple gnawed by adult roundheaded apple-tree borer. (Original.)

orchard and all surrounding host trees are cleared of the borers he is likely thereafter to be troubled very little by new infestations so long as adults are kept from developing within the area. He should continue his examinations of the trees every year, however, to detect in time any fresh outbreaks arising from eggs deposited by adults that may occasionally fly into the orchard from a distance. Where this method is used all worthless trees in which the borers can breed, growing within a few hundred feet of the orchard, should

be removed. This would include service (figs. 18, 19), mountain ash, wild crab, and thorn trees in woods, as well as the cultivated fruit trees.

PAINTS AND WASHES.

Paints and washes of various kinds have frequently been recommended for use on the trunks of trees, both to prevent the beetles from depositing eggs and to kill the borers within the trees. Experience has shown that it is easier by such means to prevent the eggs from being laid than to kill the borers. Some orchardists report success by applying pure kerosene to the bark of affected trees at the places where castings show borers to be at work. The kerosene is supposed to penetrate the burrow to the insect and kill it. Others have found that this treatment does not destroy enough of the borers to make the remedy worth while, and that in addition the kerosene may kill the bark at the point of application. The danger of injury to trees by the use of kerosene or other mineral oil practically prohibits the use of these substances. Milder solutions, applied in the same way, while not so likely to injure the trees, are even less fatal to the borers.

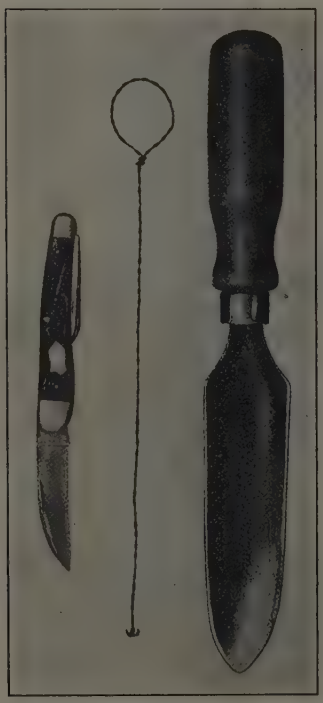

FIG. 17. Tools for use in removing roundheaded apple-tree borers from burrows. (Original.)

On the other hand, a heavy application, made just before the beginning of the egg-laying season, of some thick paint that will not injure the trees and that will maintain an unbroken coat on the bark for two or three months is very effective in preventing the female from placing her eggs in the bark. The beetle in slitting the bark with her jaws, preparatory to inserting the egg, will very rarely, if ever, make an opening through such a thick coat of paint.

Before applying paint for this purpose the earth around the base of the tree should be removed with a garden trowel or hoe to a depth of 3 or 4 inches. Bark scales and adhering earth should then be scraped from the space to be covered, and the paint applied with a

brush in the form of a band around the tree extending about a foot up the trunk and 2 or 3 inches below the level of the ground. After the paint is dry the earth removed in the beginning should be replaced. The painting may be done more thoroughly and economically by two persons working together on opposite sides of the tree.

The deterrent effect of the paint seems to arise from the mechanical barrier it presents rather than from malodorous or distasteful proper-

FIG. 18.—Clump of service bushes showing exit holes of roundheaded apple-tree borers. (Original.)

ties. The paint should cover the treated portion of the tree in a thick, solid coat, with no cracks or unpainted spaces left, as the beetles will seek out such openings in which to oviposit. Any non-injurious paint that will form a coat of the nature described will answer the purpose. A paint of pure white lead and raw linseed oil, mixed somewhat thicker than for ordinary use, will afford a fair

measure of protection to the tree, providing a heavy coat is applied in a thorough manner just previous to the beginning of the egg-laying season of the borers. The natural growth of the tree will in time cause the paint to crack, but the coat formed by one painting will remain intact and protect the tree during one egg-laying season if applied at the proper time. Better results are likely to be obtained from this treatment on young, smooth-barked trees than on old trees on which the rough bark makes a thorough job of painting more difficult. In the experience of the Bureau of Entomology, apple trees are not injured by the white-lead paint when used as directed. Others have reported injury from supposedly pure white-lead paints, but it is possible that these contained foreign and injurious substances. Those planning to use the raw linseed oil and white-lead paint should insist on receiving this article. There are several so-called tree paints and pruning paints on the market that are valuable for this purpose and appear to be safe for the trees. Annual applications of any of these paints will be necessary.

FIG. 19.—Roundheaded apple-tree borers working in young service tree. (Original.)

Gas tar has been used with some success against peach-tree borers, but should be used with caution on apple trees, as there is serious danger of injury to the bark and wood. Axle grease and paints con-

taining considerable quantities of benzine or turpentine can not be used on apple trees with safety. Some persons have had good success from the use of fish-oil soaps and carbolic-acid washes, but in tests made by the Bureau of Entomology these have not proved to be of any benefit.

MECHANICAL PROTECTORS.

Various mechanical protectors or coverings, to be placed around the lower portion of the trunk for the purpose of excluding the female beetle from the bark, have been devised. Wrappers made of newspapers are quite effective for this purpose. These wrappers, or any protectors of like nature, should be placed around the base of the trunks early in May, the season varying with the locality, and should cover the trunk from a foot or so above the ground to a short distance beneath the surface. The earth at the bottom should be mounded around the protector so as to leave no exposed portion of bark at that point. Building paper, cloth, cotton batting, fine-meshed wire screen, moss, and other materials may be used in the same way with success. Tarred paper has been recommended, but tests have shown that trees wrapped with it are likely to be injured thereby.

Such devices as those just described should be tied at the top close to the body of the tree, preferably with a piece of twine, to prevent the beetles from crawling down to oviposit between the trunk and covering. These protectors have the disadvantage of furnishing breeding and harboring places for the woolly aphis, an insect destructive to apple trees, and for that reason they should be removed from the trees as soon as possible after the egg-laying season of the borer is past. It is probably safe to remove them in any locality by the 1st of September. Eggs will be deposited occasionally around the upper margins of the protectors, but the resultant borers are easily located and destroyed. It is doubtful if trees can be protected as economically with devices of this kind as with paint, and since paint of the proper kind is of almost or quite as much value in preventing attack, it may often be used in preference to the other form of covering.

SPRAYING WITH ARSENICALS TO KILL ADULTS.

As is stated on page 10, the borer in its adult stage feeds more or less on the exposed surface of leaves and twigs (fig. 16) and on the moisture contained in fresh castings thrown out by borers still working in the trees. The quantity of food taken in this way is sufficient to enable the beetles to be killed by spraying with arsenate

of lead trees on which they are feeding. It is doubtful if it would pay ordinarily to spray orchards for the purpose of killing this insect alone, but in exceptional cases, where orchards are badly infested and are not surrounded by prolific breeding places, there is little doubt that the treatment would be profitable. Fortunately the beetles are active at the season of the year when arsenical sprays for the codling moth and other orchard pests are usually applied. These sprays, used primarily to destroy other enemies of the orchard, without doubt kill incidentally many adult roundheaded apple-tree borers.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1915